


# Percutaneous Scaphoid Fixation: Experience Value among Different Approaches

Nuno Ramos-Marques, MD<sup>1</sup> Ana Ferrão, MD<sup>1</sup> Bruno Moraes, MD<sup>1</sup> Mariana Barreira, MD<sup>1</sup>  
Frederico Teixeira, MD<sup>1</sup>

<sup>1</sup> Department of Orthopedic Surgery, Hospital Curry Cabral, Centro Hospitalar Universitário Lisboa Central, EPE, Lisboa, Portugal

**Address for correspondence** Nuno Ramos-Marques, MD, Department of Orthopedic Surgery, Hospital Curry Cabral, Centro Hospitalar Universitário Lisboa Central, EPE, Rua da Beneficência n.º8, 1069-166 Lisboa, Portugal (e-mail: Nfred.marques@gmail.com).

J Wrist Surg 2021;10:23–26.

## Abstract

**Background** Percutaneous scaphoid osteosynthesis is an attractive and increasingly popular option, as a treatment for acute scaphoid fractures in selected cases, and as an alternative to conservative treatment. The purpose of this study is to assess the radiographic positioning of the screw in percutaneous scaphoid fixation, taking into consideration the surgeons' experience, and the difference between volar and dorsal approaches.

**Methods** We retrospectively assessed patients undergoing percutaneous scaphoid fixation from 2013 to 2019. Inclusion criteria are as follows: (1) scaphoid waist fractures (Herbert's B2), (2) a minimum of 18 years of age and a maximum of 55 years of age, (3) dominant hand, (4) manual work, (5) minimum follow-up time of 6 months, and (6) without associated lesions. Criteria for correct positioning are as follows: (1) on the axis or parallel to the scaphoid axis with a maximum deviation of 1.5 mm volar/dorsal, (2) without proximal/dorsal prominence, (3) correct scaphoid alignment/reduction, and (4) absence of threads in the fracture site. Radiographs were evaluated separately by a hand surgeon, a general orthopaedic surgeon, and an orthopaedic resident.

**Results** With a total of 39 patients, a dorsal approach was performed in 10 patients and a palmar approach in 29 patients. We verified a very good interobserver reliability. The hand surgeon's team correctly positioned 15 (83.3%, 15/18), while the other team did 9 correctly (42.9%, 9/21). Comparing teams according to the approach used, the dorsal approach did not show a statistical difference, while the same was not true for the volar approach ( $p < 0.05$ ).

**Conclusion** This points to a positive impact on the team's experience in the positioning of the screws, and therefore in the benefit of treatment by teams dedicated to the area, while daring to suggest that less-experienced surgeons should utilize the dorsal approach.

## Keywords

- dorsal/volar approach
- experience
- percutaneous fixation
- positioning
- scaphoid fracture

Scaphoid fractures comprise approximately 2 to 3% of all wrist fractures. They are the most common carpal fracture,<sup>1,2</sup> representing 50 to 90% of carpal fractures and 11% of all hand fractures.<sup>3</sup> The waist of the scaphoid is fractured in most of the cases (>70%).<sup>4</sup> Nowadays, percutaneous screw fixation is a very popular treatment option in the management of acute displaced scaphoid fractures. It can

also be used as an alternative to conservative treatment in young active individuals with nondisplaced scaphoid fractures since it shortens the immobilization period, time to union, and allows for an early return of function/work.<sup>5</sup>

Both volar (retrograde) and dorsal (antegrade) approaches for nondisplaced or minimally displaced scaphoid waist fractures have been described. No clear superiority of one approach

received

May 25, 2020

accepted

July 14, 2020

published online

September 10, 2020

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Thieme Medical Publishers, Inc.,  
333 Seventh Avenue, 18th Floor,  
New York, NY 10001, USA

DOI <https://doi.org/10.1055/s-0040-1716352>.  
ISSN 2163-3916.

over the other has been demonstrated to date, concerning mechanical stability, ease of access, time to union, and anatomic visualization.<sup>6,7</sup>

Thus, the choice as to a volar or dorsal approach is left to the surgeon's preference. Regardless of the approach, several biomechanical studies have demonstrated that optimal mechanical fixation is achieved when the screw is placed down the central longitudinal axis of the scaphoid.<sup>7-9</sup>

The purpose of this study is to compare variance in ideal screw position, taking into consideration the surgeons' level of expertise,<sup>10</sup> and to compare antegrade and retrograde screw fixation of scaphoid waist fractures, as it relates to central screw placement. We hypothesized that being treated by a highly experienced specialist, "hand surgeon," would lead to a better screw positioning and that, a dorsal antegrade screw insertion would lead as well, to a better screw positioning, regardless of the surgeons' category, compared with the retrograde approach.<sup>11</sup>

## Methods

Institutional review board approval was obtained. A retrospective evaluation of the patients who underwent surgical fixation of scaphoid fractures was performed between 2013 and 2019. The type of approach used was at the discretion of the treating surgeon. Demographic information was collected including patient age and gender. Fractures were classified according to Herbert's classification. Inclusion criteria

are as follows: (1) scaphoid waist fractures (Herbert's B2), a minimum of 18 years of age and a maximum of 55 years of age, (2) dominant hand; (3) manual work labor, (4) minimum follow-up of 6 months, and (5) without associated lesions (such as scapholunate ligament rupture and other fractures). As criteria to correct positioning of the screw, we considered (1) screw fixation in the scaphoid axis or parallel to the axis with a maximum distance of 1.5 mm volar/dorsal or radial/ulnar, (2) without dorsal or volar prominence, (3) correct reduction/alignment of the scaphoid, and (4) absence of threads in the fracture plane. Only patients with postoperative radiographs were considered, taking into consideration the anteroposterior (AP) and lateral views. Measurements were performed using PACS software (SECTRA). All patients were treated with a percutaneous or mini-open technique. All postoperative radiographs were reviewed by three observers (one fellowship-trained hand surgeon, one general orthopaedic surgeon, and one orthopaedic resident). Each observer rated the screw location as correct or incorrect (►Fig. 1). Regarding the categorization of surgeons' level of expertise and adopting the criteria published by Tang and Giddins, the hand surgeon's team was considered to be a category 4 and the general orthopaedic surgeons' team as category 3.

Statistical analysis was performed using Fisher's exact test. A  $p$ -value of  $p < 0.05$  was considered statistically significant. Measures of the interobserver reliability were assessed using a kappa ( $\kappa$ ) statistic, with a  $\kappa$  value of  $< 0.20$  considered poor,



**Fig. 1** Categorization of screw placement. (A) Posteroanterior view of the scaphoid. (B) Lateral view of the scaphoid. A screw positioned between the two lines was considered central. (C) Example of a correct volar/retrograde approach. (D) Example of an incorrect volar/retrograde approach).

0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, substantial; and 0.81 to 1.00, very good reliability.

## Results

The patient group consisted of 34 (87.2%) men and 5 (12.8%) women with an average age of 33.5 years (range: 18–52 years). There was a corresponding age and gender distribution between the two groups.

The average waiting time for surgery was 23.2 days (range: 1–90 days).

In total, 24 were correctly positioned and 15 were incorrectly positioned. The average  $\kappa$  value among observers was 0.82, denoting very good interobserver reliability.

Between teams, 18 fractures were performed by the hand surgeon's team and 21 by general orthopaedic surgeons. The hand surgeon's team correctly positioned 15 and incorrectly 3 (83.3%, 15/18); 3 via the dorsal approach and 15 via the volar approach.

The other team correctly positioned 9 and 12 incorrectly (42.9%, 9/21); 7 via the dorsal approach, and 14 via the volar approach.

Overall the difference between teams was statistically significant ( $p < 0.05$ , Fisher's exact test).

Comparing teams according to the approach used, the dorsal approach did not show a statistically significant difference in the correct positioning of the screw ( $p > 0.05$ , Fisher's exact test), the same was not true for the volar approach.

## Discussion

The current standard of treatment for scaphoid fractures is the headless compression screw. When taking into consideration the fracture plane, a scaphoid waist fracture can be managed either with a volar approach or a dorsal approach with similarly high fracture union rates.<sup>12</sup> In a proximal pole fracture, typically a dorsal approach is used, while a distal pole fracture, a volar approach is preferred.

McCallister et al, in a cadaveric model, stated that placement of the screw along the central axis of the scaphoid is biomechanically superior to an eccentric placement.<sup>8</sup>

Placement of the headless screw along the scaphoid central axis allows the longest screw length, which in turn, leads to greater biomechanical stability and greater union rates.<sup>8,13,14</sup> As such, the universal recommendation is to place the screw along the central axis of the scaphoid.

In a study performed by Trumble et al,<sup>15</sup> he concluded that when the central placement was compared with a peripheral placement, the central placement was found to be associated with a shorter time to union ( $p < 0.01$ ; Kaplan–Meier estimate). Likewise, the probability of a persistent nonunion was greater when the screw had been placed peripherally than when it had been placed centrally ( $p < 0.01$ ).

In a cadaveric comparison of proximal and distal techniques, Chan and McAdams demonstrated that the proximal/dorsal approach to percutaneous screw fixation of scaphoid waist fractures allowed for more central placement in the

distal pole; however, without any difference in screw location in the proximal pole and waist regions.<sup>7</sup>

Similarly, multiple authors such as Jeon et al, Berg et al, or Slade et al advocate for the dorsal/antegrade approach to treat waist fractures, since it allows screws to be placed more parallel to the central axis.<sup>11,16,17</sup>

When a standard volar approach is used, a guidewire is inserted percutaneously into the tubercle, which causes an eccentric screw placement at the distal pole. In the retrograde approach, the trapezium obstructs the entrance to the distal pole. To improve the screw trajectory from this approach, Meermans et al<sup>18</sup> investigated a transtrapezial technique compared with starting the screw at the volar scaphoid tubercle. Meermans et al studied states that the transtrapezial technique can consistently place the screw in the central third of the proximal and distal poles and that this imparted a significant mechanical advantage. However, it seems that the downside of the transtrapezial path is scaphotrapeziotrapezoid arthritis. It seems that the risk of scaphotrapezial osteoarthritis is increased with surgical treatment, but this complication has also been seen in a one-fourth to two-thirds of patients in whom a scaphoid fracture was treated with plaster immobilization.<sup>19</sup> Risk factors related to the percutaneously applied dorsal and volar approaches on anatomical structures have been discussed in several studies. During the dorsal approach, the extensor pollicis longus, the superficial radial nerve, and the terminal portion of the posterior interosseous nerve are at risk.<sup>20</sup>

As stated previously, the purpose of the present investigation was to directly compare the radiographic screw positioning when a hand surgeon or a general orthopaedic surgeon performed the surgery. We also tried to determine which approach was superior in achieving central screw placement. It is widely known that surgeon volume increases the rate of success, denotes improved clinical/functional outcomes, and decreases the rate of complications.<sup>21,22</sup> As a consequence, it is invariable that a hand surgeon has more experience and a larger volume when dealing with this pathology.

When comparing our results, differentiating patients were treated by a hand surgeon or a general orthopaedic surgeon, there was a significant difference ( $p < 0.05$ ). Regarding the difference between the two approaches, we noticed a significant difference when using a retrograde/volar approach ( $p < 0.05$ ), while there was no significant difference when using the dorsal/antegrade approach ( $p > 0.05$ ).

Resembling the work of Liverneaux et al, and since in our hospital we resort to conventional fluoroscopy, in the anteroposterior view, the average screw axis is slightly lateral concerning the scaphoid axis and for the most part, in the lateral view, posterior to the scaphoid axis, thus also avoiding the anterior surface of the scaphoid tubercle, where some vascularization occurs.<sup>23</sup>

While it does appear that antegrade screw insertion leads to better positioning, the reasons for the superiority over the retrograde approach are unclear. It seems that the trapezium obstructs the ideal point for screw insertion, which may yield difficulties when achieving ideal screw positioning. So, the transtrapezial approach may solve this problem. A dorsal

approach seems to be simpler, with an easier learning curve, leading to a higher percentage of correctly positioned screws, as such, we suggest that nonexperienced surgeons should try to use this approach.

## Limitations

There are several limitations to our study. Contemplating computerized tomographic (CT) scanning, applied in the majority of studies to determine the ideal positioning of the screw (in cadavers), in our hospital center, it is not a common practice. Not only because of the increased amount of ionizing radiation patients would be subjected to but also because it is not ethical to perform this type of examination if the patient is clinically well, not to mention the increase in hospital expenses. Regarding the type of study performed, retrospective study, we did not contemplate the functional outcomes of the patients or actual radiographic union. Instead, we restricted our study to radiographic screw placement outcomes.

## Conclusion

In line with the available literature, percutaneous scaphoid osteosynthesis is an attractive and increasingly popular option, as a treatment for acute scaphoid fractures, in selected cases and as an alternative to conservative treatment. It allows an earlier functional return and a shorter period of immobilization with excellent consolidation rates.

In addition to this evidence, our results point to a positive impact on the team's experience in the correct positioning of the screws, and therefore in the benefit of treatment by teams dedicated to the area, as well as we dare to suggest that less experienced surgeons should use a dorsal approach when dealing with waist fractures of the scaphoid.

### Note

Informed consent was not sought for this article because all patient's information remained confidential.

### Ethical Approval

Ethical approval for this study was obtained from ethics committee for health from Centro Hospitalar Universitário Lisboa Central, EPE, approval number: 888/2020.

### Funding

None.

### Conflict of Interest

None declared.

## References

- Garala K, Taub NA, Dias JJ. The epidemiology of fractures of the scaphoid: impact of age, gender, deprivation and seasonality. *Bone Joint J* 2016;98-B(05):654–659
- Duckworth AD, Jenkins PJ, Aitken SA, Clement ND, Court-Brown CM, McQueen MM. Scaphoid fracture epidemiology. *J Trauma Acute Care Surg* 2012;72(02):E41–E45
- Suh N, Benson EC, Faber KJ, Macdermid J, Grewal R. Treatment of acute scaphoid fractures: a systematic review and meta-analysis. *Hand (N Y)* 2010;5(04):345–353
- Fowler JR, Hughes TB. Scaphoid fractures. *Clin Sports Med* 2015;34(01):37–50
- Pinder RM, Brkljac M, Rix L, Muir L, Brewster M. Treatment of scaphoid nonunion: a systematic review of the existing evidence. *J Hand Surg Am* 2015;40(09):1797–1805.e3
- Luria S, Lenart L, Lenart B, Peleg E, Kastelec M. Optimal fixation of oblique scaphoid fractures: a cadaver model. *J Hand Surg Am* 2012;37(07):1400–1404
- Chan KW, McAdams TR. Central screw placement in percutaneous screw scaphoid fixation: a cadaveric comparison of proximal and distal techniques. *J Hand Surg Am* 2004;29(01):74–79
- McCallister WV, Knight J, Kaliappan R, Trumble TE. Central placement of the screw in simulated fractures of the scaphoid waist: a biomechanical study. *J Bone Joint Surg Am* 2003;85(01):72–77
- Leventhal EL, Wolfe SW, Walsh EF, Crisco JJ. A computational approach to the “optimal” screw axis location and orientation in the scaphoid bone. *J Hand Surg Am* 2009;34(04):677–684
- Tang JB, Giddins G. Why and how to report surgeons' levels of expertise. *J Hand Surg Eur Vol* 2016;41(04):365–366
- Jeon IH, Micic ID, Oh CW, Park BC, Kim PT. Percutaneous screw fixation for scaphoid fracture: a comparison between the dorsal and the volar approaches. *J Hand Surg Am* 2009;34(02):228–36.e1
- Kang KB, Kim HJ, Park JH, Shin YS. Comparison of dorsal and volar percutaneous approaches in acute scaphoid fractures: a meta-analysis. *PLoS One* 2016;11(09):e0162779
- Trumble TE, Gilbert M, Murray LW, Smith J, Rafiqah G, McCallister WV. Displaced scaphoid fractures treated with open reduction and internal fixation with a cannulated screw. *J Bone Joint Surg Am* 2000;82(05):633–641
- Dodds SD, Panjabi MM, Slade JF III. Screw fixation of scaphoid fractures: a biomechanical assessment of screw length and screw augmentation. *J Hand Surg Am* 2006;31(03):405–413
- Trumble TE, Clarke T, Kreder HJ. Non-union of the scaphoid. Treatment with cannulated screws compared with treatment with Herbert screws. *J Bone Joint Surg Am* 1996;78(12):1829–1837
- Ten Berg PWL, Dobbe JGG, Brinkhorst ME, et al. Scaphoid screw fixation perpendicular to the fracture plane: comparing volar and dorsal approaches. *Orthop Traumatol Surg Res* 2018;104(01):109–113
- Slade JF III, Grauer JN, Mahoney JD. Arthroscopic reduction and percutaneous fixation of scaphoid fractures with a novel dorsal technique. *Orthop Clin North Am* 2001;32(02):247–261
- Meermans G, Van Glabbeek F, Braem MJ, van Riet RP, Hubens G, Verstreken F. Comparison of two percutaneous volar approaches for screw fixation of scaphoid waist fractures: radiographic and biomechanical study of an osteotomy-simulated model. *J Bone Joint Surg Am* 2014;96(16):1369–1376
- Saedén B, Törnkvist H, Ponzer S, Höglund M. Fracture of the carpal scaphoid. A prospective, randomised 12-year follow-up comparing operative and conservative treatment. *J Bone Joint Surg Br* 2001;83(02):230–234
- Adamany DC, Mikola EA, Fraser BJ. Percutaneous fixation of the scaphoid through a dorsal approach: an anatomic study. *J Hand Surg Am* 2008;33(03):327–331
- Malik AT, Jain N, Scharschmidt TJ, Li M, Glassman AH, Khan SN. Does surgeon volume affect outcomes following primary total hip arthroplasty? A systematic review. *J Arthroplasty* 2018;33(10):3329–3342
- Zhou C, Ceyisakar IE, Hovius SER, et al. Surgeon volume and the outcomes of dupuytren's surgery: results from a dutch multicenter study. *Plast Reconstr Surg* 2018;142(01):125–134
- Liverneaux PA, Gherissi A, Stefanelli MB. Kirschner wire placement in scaphoid bones using fluoroscopic navigation: a cadaver study comparing conventional techniques with navigation. *Int J Med Robot* 2008;4(02):165–173